PROXCACHE: A NEW CACHE DEPLOYMENT STRATEGY IN INFORMATION-CENTRIC NETWORK FOR MITIGATING PATH AND CONTENT REDUNDANCY

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Abstrak

Salah satu paradigma yang menjanjikan perkongsian sumber adalah dengan mengekalkan asas semantik Internet ialah Rangkaian Maklumat Berpusat (ICN). Perbezaan ICN dengan Internet semasa adalah dari segi keupayaan merujuk kandungan melalui nama dan sebahagiannya dengan memutuskan amalan hos-ke-hos pada alamat-alamat protocol *Internet*. Tambahan pula, pengagregatan kandungan dalam *ICN* dilihat sebagai tindakan utama untuk mencapai rangkaian-kandungan bagi tujuan mengurangkan jumlah capaian pelayan. Amalan pengagregatan semasa dalam ICN menggunakan *Tinggalkan Salinan di Semua Tempat*, menjanakan masalah lebihan pemendapan kandungan yang dikenali sebagai kelewahan kandungan, kelewahan laluan, kurang kadar kenaan-cache dalam pelbagai rangkaian dan rendah kepelbagaian kandungan. Kajian ini mencadangkan strategi baru mengatur kedudukan cache yang dirujuk sebagai *ProXcache* untuk memperoleh hubungan nod menggunakan konsep hiper-pinggir daripada hiper-graf untuk menentukan kedudukan cache. Kajian ini merumuskan hubungan melalui anggaran laluan dan jarak untuk mengurangkan kelewahan kandungan dan laluan. Kajian ini mengguna pakai pendekatan Reka Bentuk Kaedah Penyelidikan (DRM) untuk mencapai objektif-objektif penyelidikan. ProXcache telah dikaji menggunakan penyelakuan pada topologi rangkaian Abilene, GEANT dan DTelekom untuk strategi pengagregatan *LCE* dan *ProbCache* dengan menggunakan taburan *Zipf* untuk membezakan pengkategorian kandungan. Hasil kajian menunjukkan kelewahan kandungan dan laluan keseluruhan dikurangkan dengan operasi pengagregatan kurang enam pengendapan untuk setiap permintaan berbanding sembilan dan sembilan belas bagi *ProbCache* dan *LCE* masing-masing. ProXcache menghasilkan nisbah kepelbagaian kandungan yang lebih baik iaitu 80% berbanding 20% dan 49% untuk LCE dan ProbCache apabila saiz cache diperbagaikan.Hal ini juga meningkatkan nisbah kenaan-cache melalui kedudukan proksi dalam *ProXcache*. Semua ini ada pengaruh yang signifikan pada pembangunan ICN untuk pengurusan kandungan yang lebih baik ke arah penggunaan dalam Internet masa depan.

Kata kunci: Internet Masa Depan, Kepelbagaian kandungan, Strategi pengagregatan, Hiper-graf

Abstract

One of the promising paradigms for resource sharing with maintaining the basic Internet semantics is the Information-Centric Networking (ICN). ICN distinction with the current Internet is its ability to refer contents by names with partly dissociating the host-to-host practice of Internet Protocol addresses. Moreover, content caching in ICN is the major action of achieving content networking to reduce the amount of server access. The current caching practice in ICN using the Leave Copy Everywhere (LCE) progenerate problems of over deposition of contents known as content redundancy, path redundancy, lesser cache-hit rates in heterogeneous networks and lower content diversity. This study proposes a new cache deployment strategy referred to as ProXcache to acquire node relationships using hyperedge concept of hypergraph for cache positioning. The study formulates the relationships through the path and distance approximation to mitigate content and path redundancy. The study adopted the Design Research Methodology approach to achieve the slated research objectives. ProXcache was investigated using simulation on the Abilene, GEANT and the DTelekom network topologies for LCE and ProbCache caching strategies with the Zipf distribution to differ content categorization. The results show the overall content and path redundancy are minimized with lesser caching operation of six depositions per request as compared to nine and nineteen for ProbCache and LCE respectively. ProXcache yields better content diversity ratio of 80% against 20% and 49% for LCE and ProbCache respectively as the cache sizes varied. ProXcache also improves the cache-hit ratio through proxy positions. These thus, have significant influence in the development of the ICN for better management of contents towards subscribing to the Future Internet.

Keywords: Future Internet, Content diversity, Caching strategy, Hypergraph.

Declaration Associated with This Thesis

Some part of the work presented in this thesis have been published and submitted to the following journals and conferences listed below:

[1] **Ibrahim Abdullahi**, Suki Arif, and Suhaidi Hassan. Survey on caching approaches in information centric networking. *Elsevier Journal of Network and Computer Applications, (56):48-56, July 2015. Rank Q1, ISI and Scopus Indexed.*

[2] **Ibrahim Abdullahi**, Suki Arif, and Suhaidi Hassan. Ubiquitous Shift with Information Centric Network Caching Using Fog Computing. *Advances in Intelligent Systems and Computing. Springer International Publishing, (331):327-335, January 2015. ISI and Scopus Indexed.*

[3] **Ibrahim Abdullahi**, Suhaidi Hassan, and Suki Arif. Prospective Use of Bloom Filter and Muxing for Information Centric Network Caching. *ARPN Journal of Engineering and Applied Sciences, 10(3):1169–1177, February 2015. Scopus Indexed.*

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Dedication

To my family and TEACHERS at all capacity of my Knowledge pursuit.

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List of Abbreviations

AS	-	Autonomous System
CCN	-	Content Centric Network
COMET	-	Content Mediator Architecture for Content Aware Network
CS	-	Content Store
DHT	-	Distributed Hash Table
DONA	-	Data Oriented Network Architecture
DRM	-	Design Research Methodology
DS-I	-	Descriptive Study-I
DS-II	-	Descriptive Study-II
EU	-	European Union
FIB	-	Forwarding Information Base
ICN	-	Information Centric Network
ICNRG	-	Information Centric Network Research Group
IP	-	Internet Protocol
ISP	-	Internet Service Provider
LCD	-	Leave Copy Down
LCE	-	Leaave Copy Everywhere
MDHT	-	Mulitlevel Distributed Hash Table
NDO	-	Named Data Object
NetInf	-	Network of Information
NR	-	Name Resolution
NRS	-	Name Resolution System
PIT	-	Pending Interest Table
PS	-	Perspective Study
PRE	-	Path Redundancy Elimination
ProbCache	-	Probabilistic Cache
ProXcache	-	ProXy Cache
PSIRP	-	Publish-Subscribe Internet Routing Paradigm
PURSUIT	-	Publisher Subscriber Internet Technology

P2P	-	Peer-2-Peer
RENE	-	Rendezvous Network
RH	-	Resource Handlers
SAIL	-	Scalable Adaptive Internet Solution
SMA	-	Shared Memory Architecture
SSL	-	Secure Socket Layer
TSB	-	Time Since Birth
TSI	-	Time Since Inception
UGC	-	User Generated Content
URL	-	Uniform Resource Locator
VNI	-	Virtual Network Index
VoD	-	Video on Demand

CHAPTER ONE
INTRODUCTION

1.1 General Overview

Information dissemination has been the main idea that gave birth to the Internet. Its flexibility has since been widely acceptable due to the Internets benefits out-weighing the threats of security, privacy and other vulnerabilities associated to its practice. The current Internet was built on the architectural plan of host-to-host communication idea. However, benefiting users are tending to be less concerned about the host of these information with the quest of having to concentrate more on the content ahead of the host address. This practice on the Internet is therefore seen as the projection for the future Internet to Internet of Things (IoT), Internet of Everything (IoE), Cloud infrastructure and fifth generation (5G) technology. With the huge amount of data being requested and transferred over the Internet hitting the mark of about 1,000 *Exabytes* (*Zettabyte*) in year 2016 according to Cisco *Virtual Network Index* (VNI) [1, 2, 3]. Therefore, a need to subscribe into the Information-Centric Networking is deemed appropriate. As the name implies, Information Centric Network (ICN) [4, 5] usually described alongside Networking Named Content [6] is aimed at achieving the possibilities of bringing a new dimension and improved information dissemination on the Internet.

The major point of distinction between the traditional/conventional Internet will be its ability to use names (content-aware) and not the host address content like the conventional Internet Protocol (IP) addressing. Several researches and studies have received huge interests by proposing various architectural platforms in ICN to meet the yearned aspiration for a shift to content-centric networking. ICN projects has proven that the aspiration will soon be a success in line with the huge support it has been receiving through European Union FP7 projects, Internet Research Task Force (IRTF) and Inter-

The contents of the thesis is for internal user only

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